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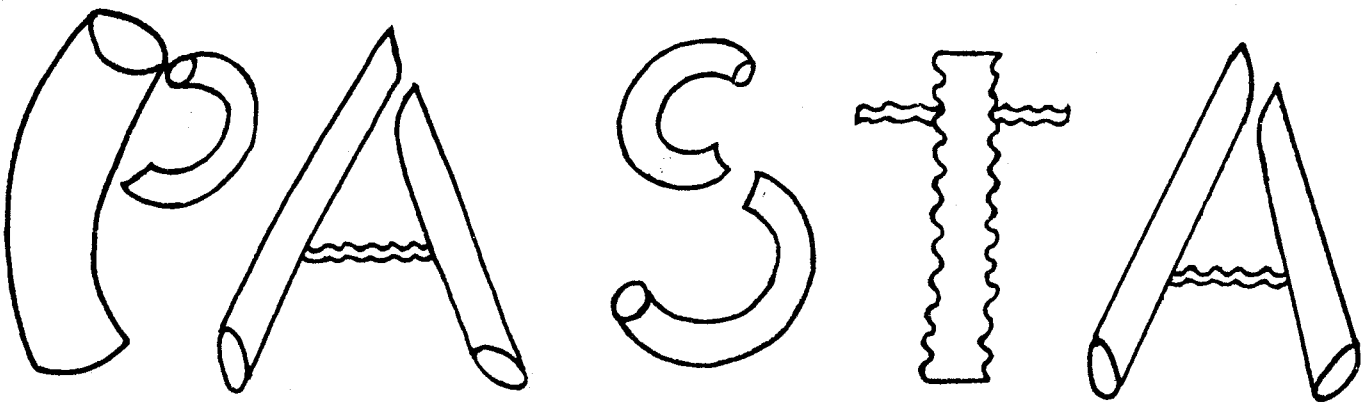
Update of...

An Analysis of the Economic Feasibility of Processing



Products in North Dakota

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FOREWORD

This supplemental study provides updated information on the pasta industry including production capacity, pasta utilization, and estimates of future demand. The authors express their appreciation to the many individuals in the pasta industry who provided information for this publication. The authors gratefully acknowledge the valuable assistance and suggestions from the faculty and staff of the Department of Agricultural Economics, North Dakota State University.

The financial support provided by the Red River Planning Council, the North Central Planning Council, and the North Dakota Business and Industrial Development Department have made this supplemental study of the pasta industry possible.

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Highlights

Dramatic increases in transportation rates, increased demand for pasta products, and a rapid decline in the number of pasta plants have demonstrated the need for an update of the 1974 North Dakota pasta plant feasibility study.

Durum milling capacity has increased approximately 7 percent from 1973 through 1977. Since that time, two durum mills have closed while two other mills were opened.

The number of pasta processing plants operated in the United States has declined from approximately 135 in 1973 to approximately 75 plants in 1978. Although the number of plants has decreased dramatically in recent years, pasta production capacity has increased by approximately 40 percent from 16,674,254 cwt. in 1971 to 23,140,000 cwt. in 1978.

Per capita consumption of pasta was estimated at 10.0 pounds in 1977 and projected to be 12.0 pounds by 1985. Total pasta consumption in the United States was estimated at 21,773,900 cwt. in 1977 and is estimated to be 28,565,640 cwt. in 1985, representing a 30 percent increase in consumption from 1977 to 1985.

Short- and long-run pasta marketing patterns were simulated through the use of a linear programming transportation model. The pasta industry was considered in 8 durum producing regions, 7 durum milling regions, 15 pasta production regions, and 11 pasta consumption regions. The objective of the transportation analysis was to identify potential markets and optimum quantities for pasta produced in North Dakota under short- and long-run marketing periods.

The results of the transportation analysis indicate that a North Dakota based plant could effectively compete with plants at other locations for a share of the existing pasta market. The North Dakota plant could also supply a portion of the pasta needs in the future. A limitation of the study was the need to estimate a number of rail rates due to a lack of adequate rate data on certain pasta movements covered in the model.

Update of An Analysis of the Economic Feasibility of Processing Pasta Products in North Dakota

by

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This supplement updates information contained in "An Analysis of the Economic Feasibility of Processing Pasta Products in North Dakota," published by the Department of Agricultural Economics, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, in cooperation with the Economic Development Administration of the United States Department of Commerce, Bulletin 496.

Considerable interest has been demonstrated by the pasta industry in plant expansion since the publication of the original study in 1974. Increasing demand for pasta products, drastic decreases in the number of pasta processing plants, and dramatic increases in transportation rates have also demonstrated the need for this updated supplement.

Production, Milling, and Processing of Durum Wheat into Pasta Products

In recent years the pasta industry has continued trends outlined in the original 1974 feasibility study. Recent trends for each segment of that industry are summarized below.

Durum Production

Durum production in the United States has increased over 80 percent from 1972 to 1978, while durum production in North Dakota has increased over 55 percent over the same time period (Table 1). North Dakota continues to supply the major proportion of durum produced in the United States.

Although production has fluctuated dramatically in recent years, durum remains an important cash crop for farmers in North Dakota (Table 2). This fluctuation can be attributed, at least in part, to stocks on hand. North Dakota remains in an excellent position to supply the needed durum for a durum mill-pasta processing plant. No indications appear that durum production will be replaced in the near future by competing crops in North Dakota.

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*Mittleider is Research Assistant and Anderson is Professor, Department of Agricultural Economics.

TABLE 1. ESTIMATED DURUM PRODUCTION IN THE UNITED STATES, BY STATE, 1972-1978

State	Year						
	1972	1973	1974	1975	1976	1977	1978
	(000's of bushels)						
Arizona	--	--	--	--	23,925	6,120	6,370
California	156	100	150	1,095	6,400	2,100	8,625
Minnesota	992	2,088	2,352	2,828	2,744	2,829	3,773
Montana	4,221	4,004	5,073	10,125	8,555	4,840	8,700
New Mexico	--	--	--	--	1,190	296	--
North Dakota	65,493	69,575	70,800	104,940	90,500	60,515	102,060
South Dakota	2,050	2,688	2,870	4,374	1,600	3,264	3,800
Total U.S.	72,912	78,455	81,245	123,362	134,914	79,964	133,328
North Dakota % of Total	89.8	88.7	87.1	85.1	67.1	75.7	76.5

SOURCES: U.S. Department of Agriculture, Agricultural Statistics, 1973, 1975, 1977, U.S. Government Printing Office, Washington, D.C.

U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Crop Production, January 16, 1978, p. B-24 and December 8, 1978, p. B-13.

Durum Milling and Pasta Processing in the United States

Durum milling capacity has increased approximately 7 percent since the publication of the original study in 1974. Since 1973, two mills were closed, one in California and the other in Pennsylvania, while two new mills were opened, one in New York and the other in Oregon (Table 3). Although the durum mill in Calfiornia is no longer operating, durum wheat is still being milled in that state.

Durum wheat ground and straight semolina and durum flour output has increased gradually since 1972. Durum wheat ground has increased by approximately 12 percent, while straight semolina and durum flour has increased approximately 8 percent since 1972 (Table 4).

TABLE 2. NORTH DAKOTA ACRES PLANTED AND PRODUCTION OF DURUM, 1968-1977

Year	Acres Planted	Production
	(000)	(000 bu.)
1968	3,012	83,420
1969	2,831	91,773
1970	1,812	43,800
1971	2,592	82,063
1972	2,333	65,493
1973	2,590	69,575
1974	3,600	70,000
1975	4,080	104,940
1976	3,710	90,500
1977	2,600[a]	60,515[a]

[a]Preliminary.

SOURCE: U.S. Department of Agriculture, Statistical Reporting Service, in cooperation with North Dakota State University, Department of Agricultural Economics, North Dakota Crop and Livestock Statistics, Ag. Statistics Nos. 21, 23, 26, 29, 32, 35, 38, 40, and 42, Fargo.

The original pasta study indicated there were approximately 130 to 140 pasta processing plants operating in the United States in 1973. In 1978 industry personnel estimated approximately 70 to 80 pasta processing plants operated in the United States.

Pasta processing capacity for use in this study was aggregated into 15 major regional manufacturing areas to correspond with those used in the original study (Figure 1). Total annual production capacity for 1977 was estimated at 23,140,000 cwt., up 38.8 percent from 16,674,254 cwt. in 1971. Regional pasta processing capacity estimates were supplied by various individuals within the durum milling and pasta processing industries. Production capacity estimates by region for 1971 and 1977 are listed in Table 5. The estimates for 1977 will be utilized in the transportation analysis discussed in a later portion of this study.

TABLE 3. UNITED STATES DURUM MILLS AND THEIR DAILY CAPACITY BY STATE, 1973 AND 1977

State	1973		1977	
	Number of Mills	Capacity	Number of Mills	Capacity
		(cwt./24 hrs.)		(cwt./24 hrs.)
California	1	3,000	0	0
Louisiana	1	1,000	1	1,000
Minnesota	5	29,400	5	31,300
New York	2	10,600	3	14,800
North Dakota	1	5,000	1	5,000
Oregon	1	5,000	2	8,750
Pennsylvania	1	5,000	0	0
Wisconsin	1	9,000	1	12,000
Total	13	68,000	13	72,850

SOURCE: "1977 Milling and Grain Directory, Plants and Managers" and "Directory of Mills and Milling Executives," Milling and Baking News, Sosland Publishing Company, Kansas City, Missouri, September, 1973, and December, 1977.

Pasta Consumption in the United States

Spaghetti continues to be the leading product in terms of value of total domestic consumption, followed by macaroni and noodles (Table 6). The value of total domestic pasta consumption has increased by approximately 23 percent from $644,790,000 in 1973 to $796,180,000 in 1976.

Consumption of pasta was estimated for 1977 and projections were made for 1985. Table 7 lists historical per capita consumption of semolina and durum flour in the United States. However, first and second clear durum flour and nondurum wheat flour are currently being added to semolina in the production of pasta products. The extent of blending taking place in the industry today is unknown, indicating that per capita consumption in Table 7 is understated. Total domestic consumption of pasta is listed in Table 8. These statistics are based on durum mill grind and, according

TABLE 4. DURUM WHEAT GROUND AND SEMOLINA AND DURUM FLOUR PRODUCED, 1972-1977

Year	Durum Wheat Ground	Change From Previous Year	Straight Semolina and Durum Flour	Change From Previous Year
	(cwt.)	-----%-----	(cwt.)	-----%-----
1972	20,172,600		14,986,000	
1973	22,540,200	11.7	16,334,000	9.0
1974	19,797,000	-13.9	14,003,000	-16.6
1975	19,795,800	-0.1	13,825,000	-1.3
1976	21,075,600	6.5	15,349,000	11.0
1977	22,501,200	6.8	16,257,000	5.9

SOURCE: "Semolina Production Up," Macaroni Journal Vol. 60, No. 1, National Macaroni Manufacturers Association, Palatine, Illinois, May, 1978, p. 22.

to industry experts, more closely resemble actual per capita consumption than those statistics based on semolina and durum flour consumption.

In the original study, per capita consumption of pasta was estimated at 8.33 pounds in 1972 and projected to be 8.8 pounds by 1980. However, per capita consumption has far outgrown these estimates. Per capita consumption was estimated at approximately 10.0 pounds in 1977, and projected to be 12.0 pounds in 1985 (Table 9). Some industry personnel anticipate a doubling of per capita consumption of pasta in the United States by the end of the century.

Per capita consumption figures for 1977 were indexed by region and adjusted to 1977 population projections, allowing for regional differences in pasta consumption throughout the country. Regional per capita and domestic consumption are listed in Table 10. Figure 2 illustrates the geographical groupings of states corresponding to each of the 11 consumption regions.

Per capita consumption for 1985 was estimated by projecting historic domestic consumption data. The 12.0 pound per capita consumption figure

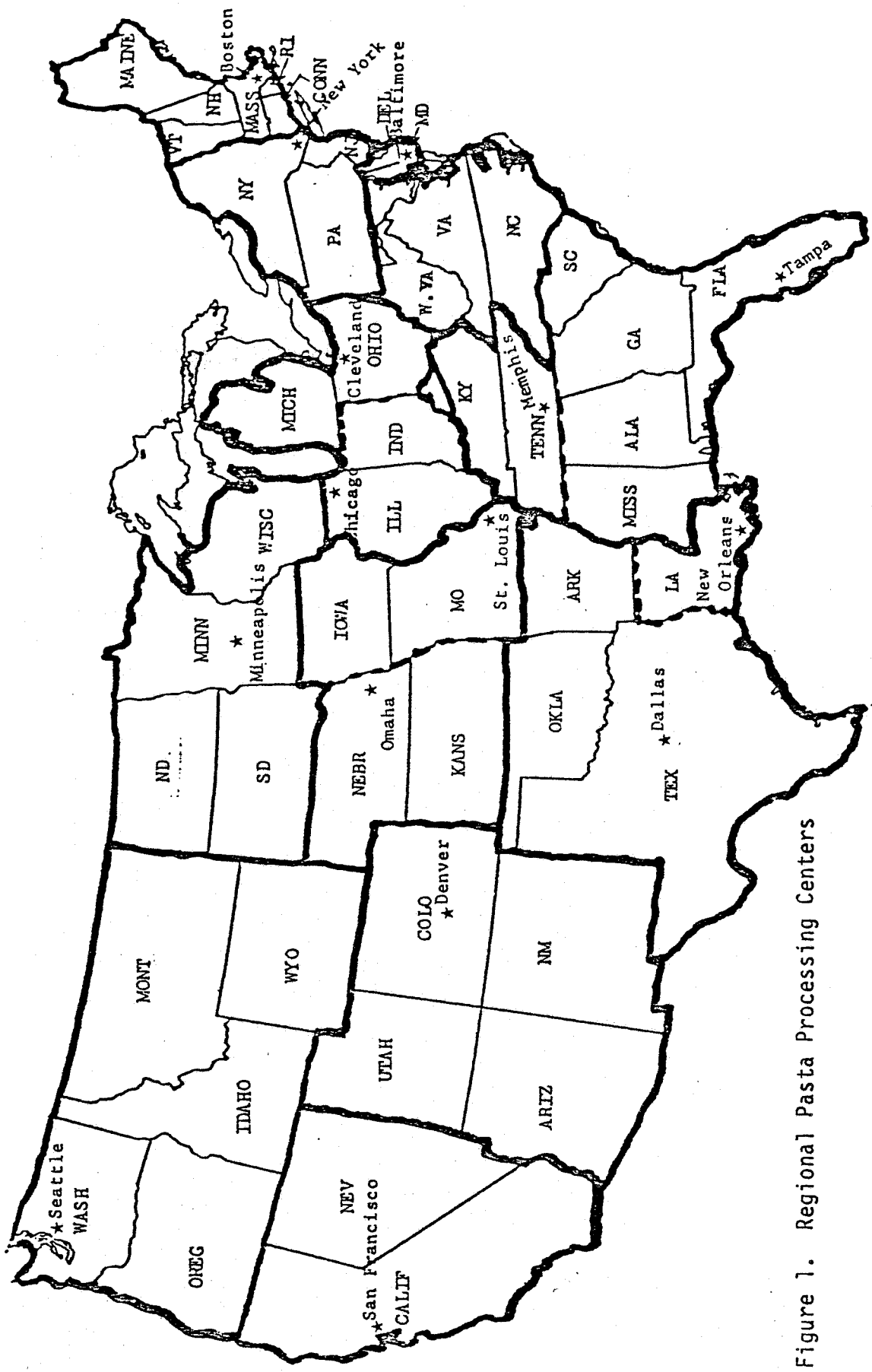

Figure 1. Regional Pasta Processing Centers

TABLE 5. ESTIMATED PASTA PRODUCTION CAPACITY OF REGIONAL MANUFACTURING CENTERS, 1971 and 1977

Selected Regional Pasta Manufacturing Center	Estimated 1971 Annual Production Capacity	Estimated 1977 Annual Production Capacity	Change
	(cwt.)	(cwt.)	(%)
San Francisco, California	1,167,198	2,280,000	95.3
Denver, Colorado	200,091	300,000	50.0
Tampa, Florida	16,674	--	--
Chicago, Illinois	2,467,790	2,910,000	17.9
New Orleans, Louisiana	16,674	400,000	2,298.9
Baltimore, Maryland	33,349	150,000	349.8
Boston, Massachusetts	1,233,894	1,200,000	-2.7
Minneapolis, Minnesota	800,364	1,500,000	87.4
St. Louis, Missouri	416,856	700,000	67.9
Omaha, Nebraska	867,061	2,050,000	136.4
New York, New York	7,086,559	8,000,000	12.9
Cleveland, Ohio	900,410	1,500,000	66.6
Memphis, Tennessee	783,690	1,000,000	27.6
Dallas, Texas	333,485	250,000	-25.0
Seattle, Washington	350,159	900,000	157.0
Total	16,674,254	23,140,000	38.8

estimated for 1985 was indexed by region and adjusted by 1985 population estimates to obtain regional per capita consumption estimates (Table 10). These consumption estimates will be used in the transportation analysis to determine optimum flows of pasta products from production points to consumption areas.

TABLE 6. VALUE OF DOMESTIC CONSUMPTION OF SELECTED PASTA PRODUCTS, 1973-1976

Product	Value of Total Domestic Consumption			
	1973	1974	1975	1976
Spaghetti	$256,150,000	$284,840,000	$308,770,000	$331,620,000
Macaroni	214,410,000	232,850,000	249,620,000	265,850,000
Noodles	174,230,000	189,390,000	199,430,000	198,710,000
Total	644,790,000	707,080,000	757,820,000	796,180,000

SOURCE: "Macaroni Dollar Volume Up in 1976," Macaroni Journal, Volume 59, No. 8, National Macaroni Manufacturers Association, Palatine, Illinois, December, 1977, p. 38.

Transportation Analysis of the Pasta Industry Including the Hypothetical North Dakota Plant

The total transportation cost for the movement of product to the final consumer is an important element in the total cost of pasta products. The competitive position of existing and proposed pasta processing plants was compared in this study because of the importance of transportation to the pasta industry. A hypothetical mill-pasta processing plant in an eastern North Dakota location was included as a possible pasta processing site.

The optimum product flows were considered to be those which took place under highest efficiency or least-cost criteria. The transportation analysis was carried out using the linear programming algorithm.

Objectives of the Transportation Analysis

The four specific objectives to be achieved by the transportation analysis are:

1. To identify potential markets, if any, for pasta produced at a North Dakota location, given the existing rate structure.
2. To determine the optimum quantity of pasta which potentially could be produced in North Dakota and shipped to consumers at a cost less than that incurred from existing pasta producing facilities.

TABLE 7. PER CAPITA CONSUMPTION OF SEMOLINA AND DURUM FLOUR, 1960-1976

Year	Semolina and Durum Flour Consumption
	(lbs.)
1960	5.3
1961	4.6
1962	3.7
1963	5.6
1964	6.0
1965	6.5
1966	6.4
1967	6.3
1968	6.2
1969	6.5
1970	6.9
1971	6.9
1972	7.2
1973	7.9
1974	6.9
1975	6.9
1976*	7.2

*Estimated.

SOURCE: USDA, Economics, Statistics, and Cooperatives Service, Food Consumption, Prices, Expenditures, Supplement for 1976 to Agricultural Economics Report No. 138, U.S. Government Printing Office, Washington, D.C., March, 1978.

TABLE 8. UNITED STATES PASTA CONSUMPTION, 1966-1977

Year	Durum Mill Grind	Pasta Exports	Pasta Imports	Domestic Consumption	Per Capita Consumption
	(cwt.)	(cwt.)	(cwt.)	(cwt.)	(lbs.)
1966	17,422,800	17,060	136,710	13,760,000	7.02
1967	17,122,800	15,400	177,226	13,454,850	6.78
1968	17,020,800	12,785	188,394	14,100,000	6.95
1969	17,857,200	15,249	228,764	15,217,410	7.43
1970	19,231,200	13,811	276,020	15,994,330	7.72
1971	19,341,600	14,660	292,078	16,700,000	8.00
1972	20,172,600	18,635	422,385	17,401,400	8.33
1973	22,573,200	25,469	455,134	18,405,640	8.76
1974	19,797,000	32,188	472,521	18,919,640	8.93
1975	19,795,800	21,017	534,933	18,993,220	8.91
1976	21,075,600	42,240	569,220	20,207,440	9.39
1977	22,501,200	35,790	575,990	21,773,900[a]	10.00[a]

[a]Estimated.

SOURCE: "Imports Up, Exports Down," Macaroni Journal, September, 1976, Vol. 58, No. 5, P. 18, and U.S. Department of Agriculture, Economics Statistics and Cooperatives Service, U.S. Foreign Agricultural Trade Statistical Report, Calendar Year 1977, U.S. Government Printing Office, Washington, D.C., June, 1978, and interviews with industry personnel.

3. To determine the magnitude of transportation cost disadvantages a pasta processing facility in North Dakota will incur to serve those pasta consuming locations it cannot ship to on a least-cost basis.
4. To determine the least-cost locations of additional pasta capacity needed to supply projected 1985 pasta production.

TABLE 9. CONSUMPTION OF PASTA PRODUCTS IN THE UNITED STATES, 1966-1985

Year	Consumption			
	Actual[a]		Projected	
	Per Capita	Total Domestic	Per Capita	Total Domestic
	(lbs.)	(cwt.)	(lbs.)	(cwt.)
1966	7.02	13,760,000	6.63	
1967	6.78	13,454,850	6.91	
1968	6.95	14,100,000	7.19	
1969	7.43	15,127,410	7.48	
1970	7.72	15,994,330	7.76	
1971	8.00	16,700,000	8.04	
1972	8.33	17,401,400	8.33	
1973	8.76	18,405,640	8.60	
1974	8.93	18,919,640	8.89	
1975	8.91	18,993,220	9.18	
1976	9.39	20,207,440	9.46	
1977	10.00	21,773,900	9.74	
1978			10.02	21,956,325
1979			10.31	22,836,135
1980			10.59	23,728,589
1981			10.87	24,654,464
1982			11.16	25,634,073
1983			11.44	26,619,278
1984			11.72	27,630,369
1985			12.00	28,565,640

[a]Industry estimates.

TABLE 10. ESTIMATED PASTA CONSUMPTION IN THE U.S., BY REGION, 1977 (ACTUAL) AND 1985 (PROJECTED)

Region	Receiving Point	Per Capita Regional Pasta Consumption		Total Regional Pasta Consumption		
		1977	1985 (Projected)	1977	1985 (Projected)	Percent Increase
		-------lbs.--------		---------cwt.----------		
1	Spokane	10.10	12.12	815,676	1,053,657	29.2
2	Los Angeles	8.90	10.68	2,009,709	2,899,191	44.3
3	Denver	8.58	10.30	634,663	786,221	23.9
4	Minneapolis	8.56	10.27	864,988	1,122,738	29.8
5	Kansas City	9.42	11.30	1,106,473	1,383,277	25.0
6	Chicago	7.60	9.12	2,816,940	3,809,455	35.2
7	Dallas	7.96	9.55	1,722,146	2,174,871	26.3
8	Birmingham	8.49	10.19	2,590,299	3,160,214	22.0
9	Richmond	8.70	10.44	1,576,287	2,044,224	29.7
10	New York	15.01	18.01	5,710,104	7,540,759	32.1
11	Boston	15.45	18.54	1,926,615	2,591,033	34.5
	Total	10.00	12.00	21,773,900	28,565,640	31.2

Method of Analysis

Three separate product movements take place within the pasta industry in the United States and are considered in this study: 1) shipment of durum wheat from producers to durum mills, 2) shipment of semolina and durum flour from mills to pasta processors, and 3) shipment of pasta products from processors to consumers.

Durum production was aggregated into eight producing regions, the Arizona-New Mexico durum production region plus the seven regions used in the original study.

The seven regional durum wheat milling centers used in this updated study included the six regions used in the original study plus a new region, Louisiana, which now contains a durum mill. The California milling region

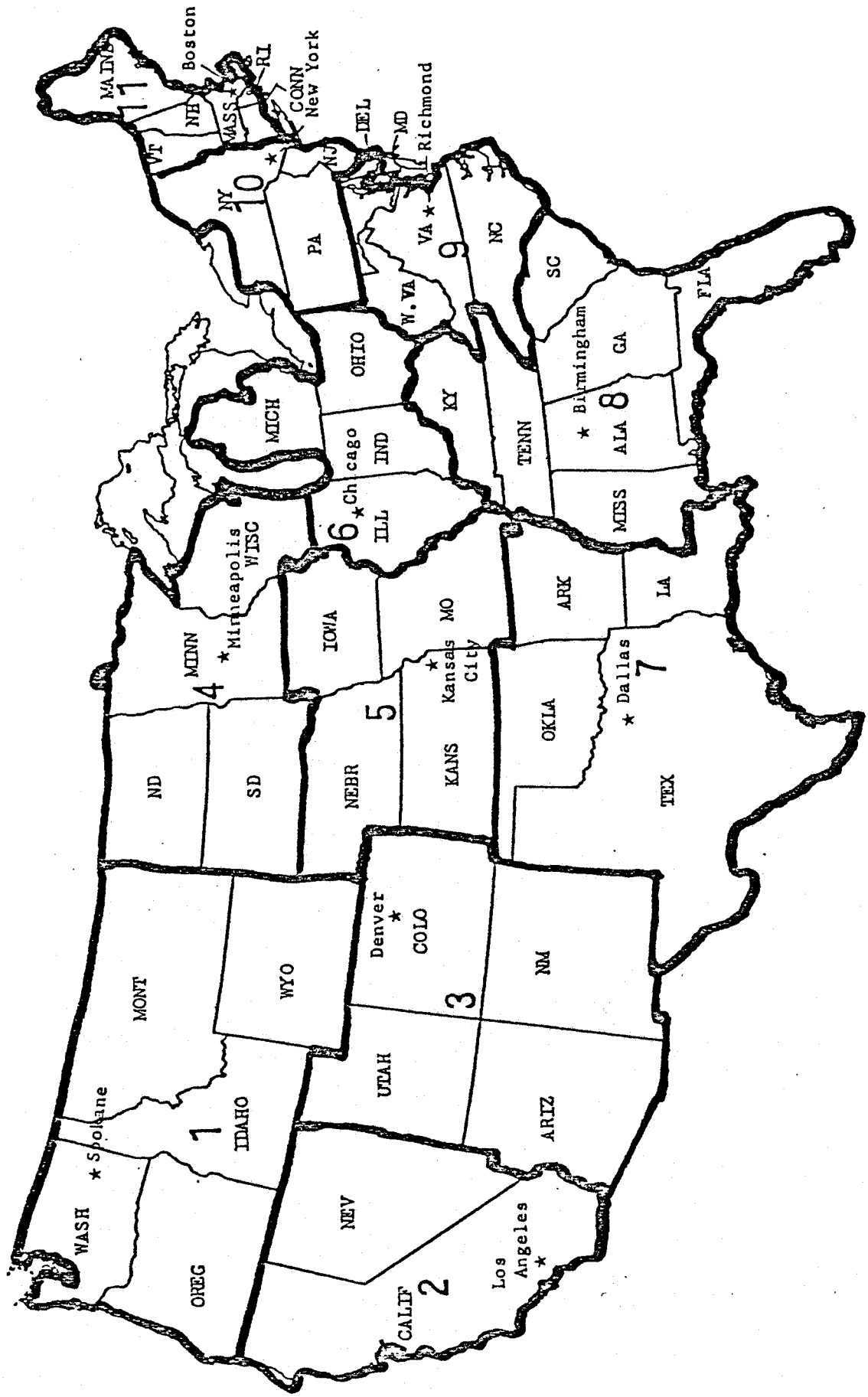

Figure 2. Pasta Consumption Regions of the United States With Central Receiving Points

was restricted to milling 2,110,200 cwt. of durum, enough to supply that region, although no durum mills currently operate in that region.

The conversion of durum wheat to mill products suitable for pasta production takes place at a rate of approximately 75 pounds of semolina and first clear flours per 100 pounds of durum wheat. Pasta processors currently blend durum and nondurum wheat flour into pasta products, although the extent of blending taking place within the industry is unknown. In an attempt to include the use of nondurum wheat flour into the transportation model product flow, adjustments were made to include an additional 20 percent of mill products suitable for pasta production. The assumption was made that the nondurum flour being blended into the product would be shipped from the durum producing regions in the form of wheat to the mill.

The pasta processing regions used in this updated supplement were the same as those used in the original study except that the Tampa processing center no longer contained any pasta processors and, therefore, was deleted. The pasta consumption regions were identical to those used in the original study.

Imports and exports entail less than 3 percent of the total domestic market. Since imports and exports were such a small portion of the total market, domestic pasta processing plants were programmed to supply the total United States market.

Due to difficulties encountered in gathering transportation rates from all production points to all consumption points the transportation rates specified in the original study were updated to more closely approximate current conditions. Rail rates were obtained for the shipments of wheat from durum producing areas to milling points. Transportation rates from milling points to pasta processing centers and from pasta processing centers to consumption points were updated by adjusting the rates from the original study by the rate increases which occurred since that time. Rail rates for the shipment of flour and pasta products have increased approximately 80 percent since mid-1973.

The production facility used in the model for the North Dakota plant utilized a durum mill in conjunction with the conventional pasta plant. This mill-plant would receive durum wheat from producers, mill the wheat, and process pasta products in one continuous operation.

Analysis of Short-Run Industry Marketing Patterns

The first stage of the transportation analysis was to execute the linear programming model for the short-run situation using 1977 consumption and plant capacity data. A North Dakota based plant was excluded from the model in the first solution, as this will serve as a base for the study of future changes in marketing patterns. Changes in marketing patterns are expected as a hypothetical North Dakota based mill-pasta plant combination is entered into the model and other parameters are changed to simulate long-run industry changes.

Optimum product flows calculated for the short-run industry situation are presented in Table 11. All 14 pasta processing centers entered the solution. Ten of 14 centers were producing at 100 percent of their estimated capacity. The pasta processing centers of California, New York, and Seattle produced at or above 88 percent of capacity, while the Ohio center produced at 42 percent of capacity.

Table 12 presents optimum short-run pasta product flows, including a hypothetical North Dakota based plant. The North Dakota plant was allowed to enter the model with unlimited capacity to ascertain the total possible market penetration. The North Dakota plant captured a significant portion of the market in Consumption Regions 3, 7, 8, and 9, marketing 3,059,038 cwt. or 14 percent of the total pasta market. The Cleveland processing location left the solution at this point, while production was decreased at four other processing locations. The production of 3,059,038 cwt. of pasta at the North Dakota site compares favorably with the results of the original study in which the plant marketed 4,232,535 cwt. of pasta.

Sensitivity of Short-Run Pasta Flows to Rate Changes

Sensitivity analysis is a mathematical technique which explores the effect of changes in the parameters on the optimum solution of a linear programming model. Of particular importance in this study are the rate structure and the effect of changes in the rate structure. Sensitivity analysis indicates the range over which selected transportation rates could vary, while all other rates were held constant, and still maintain the level of shipments attained in the least-cost solution.

The sensitivity of the rate structure of shipments of pasta from the North Dakota processing region to each consumption region was analyzed. In

TABLE 11. OPTIMUM SHORT-RUN PASTA PRODUCT FLOWS, HYPOTHETICAL NORTH DAKOTA PLANT NOT INCLUDED (FLOWS MEASURED IN CWT.)

TO Consumption Region Location / FROM Pasta Processing Location	(1) Spokane, WA	(2) Los Angeles, CA	(3) Denver, CO	(4) Minneapolis, MN	(5) Kansas City, KS	(6) Chicago, IL	(7) Dallas, TX	(8) Birmingham, AL	(9) Richmond, VA	(10) New York, NY	(11) Boston, MA	TOTAL
Minneapolis, MN				864,988			635,012					1,500,000*
Omaha, NE			334,663		1,106,473		608,864					2,050,000*
Denver, CO			300,000									300,000*
Dallas, TX							250,000					250,000*
New Orleans, LA								400,000				400,000*
St. Louis, MO							228,270	471,730				700,000*
Chicago, IL						2,816,940		93,060				2,910,000*
Cleveland, OH								625,509				625,509
Memphis, TN								1,000,000				1,000,000*
Baltimore, MD									150,000			150,000*
New York, NY									1,426,287	5,710,104	726,615	7,863,006
Boston, MA											1,200,000	1,200,000*
San Francisco, CA		2,009,709										2,009,709
Seattle, WA	815,676											815,676
TOTAL	815,676	2,009,709	634,663	864,988	1,106,473	2,816,940	1,722,146	2,590,299	1,576,287	5,710,104	1,926,615	21,773,900

*At upper limit of capacity.

TABLE 12. OPTIMUM SHORT-RUN PASTA PRODUCT FLOWS, HYPOTHETICAL NORTH DAKOTA PLANT INCLUDED (FLOWS MEASURED IN CWT.)

FROM Pasta Processing Location / TO Consumption Region Location	(1) Spokane, WA	(2) Los Angeles, CA	(3) Denver, CO	(4) Minneapolis, MN	(5) Kansas City, KS	(6) Chicago, IL	(7) Dallas, TX	(8) Birmingham, AL	(9) Richmond, VA	(10) New York, NY	(11) Boston, MA	TOTAL
Eastern ND			334,663				1,472,146	554,014	698,215			3,059,038
Minneapolis, MN				864,988					635,012			1,500,000*
Omaha, NE					1,106,473							1,106,473
Denver, CO			300,000									300,000*
Dallas, TX							250,000					250,000*
New Orleans, LA								342,000				342,000
St. Louis, MO								700,000				700,000*
Chicago, IL						2,816,940			93,060			2,910,000
Cleveland, OH												0
Memphis, TN								994,285				994,285
Baltimore, MD									150,000			150,000*
New York, NY										5,710,104	726,615	6,436,719
Boston, MA											1,200,000	1,200,000*
San Francisco, CA		2,009,709										2,009,709
Seattle, WA	815,676											815,676
TOTAL	815,676	2,009,709	634,663	864,988	1,106,473	2,816,940	1,722,146	2,590,299	1,576,287	5,710,104	1,926,615	21,773,900

*At upper limit of capacity.

those instances where no shipment of pasta occurred in the least-cost solution, sensitivity analysis provided an indication of the rate decrease required to stimulate such a flow and the volume that would be shipped. Sensitivity analysis provided an indication of the magnitude of the rate increase required before each flow would be reduced or leave the solution for pasta shipments occurring in the least-cost solution. It also provided an indication of the rate decrease required to increase the flow of pasta and the increase in volume to be expected.

As an illustration of the use of sensitivity analysis, consider the market for Consumption Region 8 in Table 13. Product shipments of 554,014 cwt. of pasta occurred from the North Dakota plant to Consumption Region 8 under the least-cost solution (Table 12). The present transportation rate is 278.0¢/cwt. In order to capture any additional market in Consumption Region 8, the transportation rate would have to fall by 14.5¢/cwt. to 263.5¢/cwt. At the reduced rate the North Dakota plant would capture an additional 698,215 cwt. of the market. Conversely, if the transportation rate increased to 281.5¢/cwt., a substantial portion of the market currently held by the North Dakota plant in Consumption Region 8 would be lost.

The short-run sensitivity analysis shows that the pasta market for the hypothetical combination mill-pasta processing plant in North Dakota is relatively unstable in the four active markets it serves (Table 13). An increase in transportation rates of 7 percent would cause the North Dakota plant to lose a substantial portion of its market share. Conversely, a 6 percent reduction in transportation rates would cause the least-cost solution to change. The Boston market, which is currently inactive, along with the active markets of Birmingham and Richmond would have the potential to increase the market share held by the North Dakota plant.

Analysis of Long-Run Marketing Patterns

An important aspect of the transportation analysis is an evaluation of the future outlook and trends in the industry. The optimum market flows which existed in 1977 may not exist in the future. Therefore, the parameters of the transportation model were changed to reflect anticipated changes in the pasta industry structure affecting long-run marketing patterns. The year 1985 was selected as the long-run time reference.

TABLE 13. TRANSPORTATION RATE SENSITIVITY FOR PASTA SHIPMENTS TO ALL MARKETS FROM NORTH DAKOTA, 1977

Market	Destination	Present Rate	Required Rate (anything less than)	Volume to be Gained	Upper Limit on Rate in Order to Retain Present Market
		(cents/cwt.)	(cents/cwt.)	(cwt.)	(cents/cwt.)
1.	Spokane, WA	446.5	202.5	5,715	a
2.	Los Angeles, CA	446.5	391.5	5,019	a
3.	Denver, CO	243.0	211.5	5,715	258.0
4.	Minneapolis, MN	109.0	65.5	698,215	a
5.	Kansas City, KS	201.5	172.5	5,715	a
6.	Chicago, IL	199.5	118.0	698,215	a
7.	Dallas, TX	276.0	225.0	5,715	294.0
8.	Birmingham, AL	278.0	263.5	698,215	281.5
9.	Richmond, VA	339.5	336.0	b	354.0
10.	New York, NY	319.5	239.5	5,715	a
11.	Boston, MA	337.5	334.0	5,715	a

[a]No shipments occur in the least-cost solution.
[b]No increase is possible even with reduced rate.

In estimating future pasta industry conditions, four revisions were made in the original transportation model in an effort to simulate 1985 market flows. First, durum production was expected to increase by 25 percent in all production regions by 1985. This increase reflects improved production technology and an increased demand. The second revision was to increase mill size by 33 percent to allow for increased milling capacity required to meet the needs of the pasta processors by 1985.

The third revision was to remove pasta processing capacity limitations for all domestic producers and allow them to produce and ship as much pasta as was optimum, since additional plant capacity could be constructed in the interim.

The final demand for pasta was expanded under the final revision from 21,773,900 cwt. consumed in 1977 to the projected 28,565,640 cwt. to be consumed in 1985.

The transportation rates for the 1977 analysis were also used in the 1985 analysis, since there was no basis upon which to project these rates.

Optimum pasta flows, without a North Dakota based plant, are shown in Table 14. All processing centers were producing pasta except at Cleveland and Memphis.

The hypothetical mill-pasta plant combination was then allowed to enter into the model with unlimited capacity (Table 15). The North Dakota plant produced 2,705,354 cwt. of pasta, shipping the entire amount to Consumption Region 8. The North Dakota plant captured the entire market previously held by the St. Louis processing center, accounting for approximately 9.5 percent of the pasta produced in 1985. These results are considerably lower than the results of the original study in which the North Dakota mill plant supplied approximately 20 percent of the market.

Rail rates for pasta moving out of North Dakota were reduced by 10 percent to determine what changes would occur in the competitive position of a North Dakota mill-plant if such a rate reduction could be negotiated. The analysis indicated that North Dakota would supply an additional 982,356 cwt. of pasta with the reduced rail rates (Table 16). The Baltimore processing location lost that portion of the market now supplied by the North Dakota plant. With this movement into Consumption Region 9 the North Dakota plant would supply approximately 13 percent of the country's market. These results are also lower than those found in the original study in which the North Dakota plant supplied approximately 24 percent of the market.

Sensitivity of Long-Run Pasta Flows to Rate Changes

The results of the sensitivity analysis of the long-run pasta flows under the present rate structure are shown in Table 17. The results indicate that relatively small changes in rates would be required before the least-cost solution would change. The North Dakota plant would supply additional pasta to its active market, Birmingham, with a 9.5¢/cwt. decrease in that transportation rate while an increase of 12.5¢/cwt. would cause the North Dakota plant to lose a substantial portion of that market.

TABLE 14. OPTIMUM LONG-RUN PASTA FLOWS, HYPOTHETICAL NORTH DAKOTA PLANT NOT INCLUDED, NO LIMIT ON CAPACITY OF PLANTS (FLOWS MEASURED IN CWT.)

FROM Pasta Processing Location / TO Consumption Region Location	(1) Spokane, WA	(2) Los Angeles, CA	(3) Denver, CO	(4) Minneapolis, MN	(5) Kansas City, KS	(6) Chicago, IL	(7) Dallas, TX	(8) Birmingham, AL	(9) Richmond, VA	(10) New York, NY	(11) Boston, MA	TOTAL
Minneapolis, MN				1,122,738								1,122,738
Omaha, NE					1,383,277							1,383,277
Denver, CO			786,221									786,221
Dallas, TX							2,174,871					2,174,871
New Orleans, LA								454,860				454,860
St. Louis, MO								2,705,354				2,705,354
Chicago, IL						3,809,455						3,809,455
Cleveland, OH												0
Memphis, TN												0
Baltimore, MD									2,044,224			2,044,224
New York, NY										7,540,759		7,540,759
Boston, MA											2,591,033	2,591,033
San Francisco, CA		2,899,191										2,899,191
Seattle, WA	1,053,657											1,053,657
TOTAL	1,053,657	2,899,191	786,221	1,122,738	1,383,277	3,809,455	2,174,871	3,160,214	2,044,224	7,540,759	2,591,033	28,565,640

TABLE 15. OPTIMUM LONG-RUN PASTA FLOWS, HYPOTHETICAL NORTH DAKOTA MILL-PLANT CAN PRODUCE, NO LIMIT ON CAPACITY OF PLANTS (FLOWS MEASURED IN CWT.)

FROM Pasta Processing Location / TO Consumption Region Location	(1) Spokane, WA	(2) Los Angeles, CA	(3) Denver, CO	(4) Minneapolis, MN	(5) Kansas, City, KS	(6) Chicago, IL	(7) Dallas, TX	(8) Birmingham, AL	(9) Richmond, VA	(10) New York, NY	(11) Boston, MA	TOTAL
Eastern ND								2,705,354				2,705,354
Minneapolis, MN				1,122,738								1,122,738
Omaha, NE					1,383,277							1,383,277
Denver, CO			786,221									786,221
Dallas, TX							2,174,871					2,174,871
New Orleans, LA								454,860				454,860
St. Louis, MO												0
Chicago, IL						3,809,455						3,809,455
Cleveland, OH												0
Memphis, TN												0
Baltimore, MD									2,044,224			2,044,224
New York, NY										7,540,759		7,540,759
Boston, MA											2,591,033	2,591,033
San Francisco, CA		2,899,191										2,899,191
Seattle, WA	1,053,657											1,053,657
TOTAL	1,053,657	2,899,191	786,221	1,122,738	1,383,277	3,809,455	2,174,871	3,160,214	2,044,224	7,540,759	2,591,033	28,565,640

TABLE 16. OPTIMUM LONG-RUN PASTA FLOWS, HYPOTHETICAL NORTH DAKOTA MILL-PLANT CAN PRODUCE, ALL LOCATIONS WITH UNLIMITED CAPACITY, 10 PERCENT RATE REDUCTION ON OUTBOUND NORTH DAKOTA PASTA MOVEMENTS (FLOWS MEASURED IN CWT.)

FROM Pasta Processing Location / TO Consumption Region Location	(1) Spokane, WA	(2) Los Angeles, CA	(3) Denver, CO	(4) Minneapolis, MN	(5) Kansas City, KS	(6) Chicago, IL	(7) Dallas, TX	(8) Birmingham, AL	(9) Richmond, VA	(10) New York, NY	(11) Boston, MA	TOTAL
Eastern ND								2,705,354	982,356			3,687,710
Minneapolis, MN				1,122,738								1,122,738
Omaha, NE					1,383,277							1,383,277
Denver, CO			786,221									786,221
Dallas, TX							2,174,871					2,174,871
New Orleans, LA								454,860				454,860
St. Louis, MO												0
Chicago, IL						3,809,455						3,809,455
Cleveland, OH												0
Memphis, TN												0
Baltimore, MD									1,061,868			1,061,868
New York, NY										7,540,759		7,540,759
Boston, MA											2,591,033	2,591,033
San Francisco, CA		2,899,191										2,899,191
Seattle, WA	1,053,657											1,053,657
TOTAL	1,053,657	2,899,191	786,221	1,122,738	1,383,277	3,809,455	2,174,871	3,160,214	2,044,224	7,540,769	2,591,033	28,565,640

TABLE 17. TRANSPORTATION RATE SENSITIVITY FOR PASTA SHIPMENTS TO ALL MARKETS FROM NORTH DAKOTA, 1985

Market	Destination	Present Rate	Required Rate (anything less than)	Volume to be Gained	Upper Limit on Rate in Order to Retain Present Market
		(cents/cwt.)	(cents/cwt.)	(cwt.)	(cents/cwt.)
1.	Spokane, WA	446.5	223.5	202,538	a
2.	Los Angeles, CA	446.5	412.0	7,201	a
3.	Denver, CO	243.0	232.0	686,792	a
4.	Minneapolis, MN	109.0	59.5	982,356	a
5.	Kansas City, KS	201.5	193.0	982,356	a
6.	Chicago, IL	199.5	121.5	982,356	a
7.	Dallas, TX	276.0	245.5	686,792	a
8.	Birmingham, AL	278.0	268.5	b	290.5
9.	Richmond, VA	339.5	326.5	982,356	a
10.	New York, NY	319.5	260.0	982,356	a
11.	Boston, MA	337.5	266.5	982,356	a

[a]No shipments occur in the least-cost solution.
[b]Quantity to be gained is unknown.

Relatively small rate reductions would be required to activate currently inactive markets. A 5 percent rate reduction would be required before the least-cost solution would change. At this point at least one of three inactive markets--Denver, Kansas City, or Richmond--would enter into the least-cost solution.

The sensitivity analysis for the long-run solution given the 10 percent rate reduction to pasta shipped out of North Dakota indicated the active and inactive markets are quite sensitive to changes in rates (Table 18). The North Dakota plant would lose a substantial portion of its market with a 1 to 8 percent transportation rate increase. Conversely, a 5 percent decrease in transportation rates would cause the least-cost solution to

TABLE 18. TRANSPORTATION RATE SENSITIVITY FOR PASTA SHIPMENTS TO ALL MARKETS FROM NORTH DAKOTA, 10 PERCENT RATE REDUCTION, 1985

Market	Destination	Present Rate	Required Rate (anything less than)	Volume to be Gained	Upper Limit on Rate in Order to Retain Present Market
		(cents/cwt.)	(cents/cwt.)	(cwt.)	(cents/cwt.)
1.	Spokane, WA	402.0	202.0	202,538	a
2.	Los Angeles, CA	402.0	391.0	7,201	a
3.	Denver, CO	219.0	211.0	786,221	a
4.	Minneapolis, MN	98.0	38.5	982,356	a
5.	Kansas City, KS	181.0	172.0	982,356	a
6.	Chicago, IL	179.5	100.5	942,168	a
7.	Dallas, TX	248.5	224.5	982,356	a
8.	Birmingham, AL	250.0	247.5	b	269.5
9.	Richmond, VA	305.5	286.0	104,802	308.0
10.	New York, NY	287.5	239.0	982,356	a
11.	Boston, MA	304.0	245.5	942,168	a

[a]No shipments occur in the least-cost solution.
[b]Quantity to be gained is unknown.

change. At least one of three inactive markets--Los Angeles, Denver, and Kansas City--would have the potential to become active, while an active market--Birmingham--would have the potential to increase the market share held by the North Dakota plant.

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